Bellcomm

955 L'Enfant Plaza North, S.W.
Washington, D. C. 20024

B72 02013

date: February 29, 1972

to: Distribution

from: A. S. Haron

subject: Effects of LRV Parking Attitude on Thermal Performance of the LCRU and LRV Batteries
Case 310

ABSTRACT

This memorandum explains the effect of the Lunar Roving Vehicle (LRV) parking attitude on thermal performance of the Lunar Communication Relay Unit (LCRU) and LRV batteries and, hence, the imposition of parking orientation constraints on the LRV. Because of conflicting thermal constraints with respect to the LCRU and the LRV batteries, the best compromise is to park the LRV at 90° to the solar vector. Any deviation towards the sun from this nominal heading will reduce the LCRU cooling rate while increasing the LRV battery cooling rate, and vice versa.

While some slight deviation from the nominal heading is tolerable, the exact magnitude of acceptable deviation is contingent on real-time thermal data. Thus, a decision on whether the parking heading has to be readjusted after the first try will, most likely, be made in real time.

(NASA-CR-126122) EFFECTS OF LRV PARKING ATTITUDE ON THERMAL PERFORMANCE OF THE LCRU AND LRV BATTERIES (Bellcomm, Inc.) 7 p

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MEMORANDUM FOR FILE

I. Introduction

This memorandum is an attempt to clarify the LRV parking orientation constraints during the cooldown periods between EVA's. It is desired that the parking attitude should be selected such that both the LRV batteries and the LCRU components can cool down to an acceptable level in preparation for the subsequent EVA.

One of the important parameters, influencing the cooldown rates of both the LCRU and the LRV batteries, is the solar energy reflected from either side of the open LRV battery cover and incident on either of the two components. Maximum cooldown of the LCRU occurs when the LRV is parked at a 180° angle from the solar vector because in that case the LCRU radiator would be completely shaded by the open LRV battery cover. Maximum cooldown of the LRV battery occurs when the LRV is parked facing the sun directly because in that case the LRV radiator would be completely shaded by its open cover. Since the thermal requirements of the two components are at variance, the nominal LRV parking attitude is set at 90° to the solar vector. This attitude avoids the incidence of reflected solar energy on either radiator.

II. Effects of Deviation from the Nominal Heading in the Direction of the Solar Vector ($\theta<90°$)

(a) The cooling rate of the LCRU will be reduced by the imposition of an additional heat source, namely the solar energy reflected from the open LRV battery cover and incident on the LCRU radiator. The attached Figure 1, from Reference 1, illustrates the LCRU cooldown performance as a function of the deviation from the nominal LRV heading, based on the assumptions listed on the figure.

For example, parking the LRV at 10° off-nominal towards the sun (θ = 80°) for 14 hours, would result in LCRU cooldown to 76°F instead of 61°F, from an initial temperature of 110°F (120°F is the red line value).

(b) The cooling rate of the LRV battery will increase due to a reduction in the direct solar heat input impinging on its radiator, resulting from partial shading by the open cover. The covers close at 45°F.

III. Effects of Deviation from the Nominal Parking Heading Away from the Solar Vector (θ>90°)

(a) The cooling rate of the LCRU will increase due to partial shading, as shown in Figure 1. For example, parking the LRV at 10° off-nominal away from the sun would result in LCRU cooldown to 47°F instead of 61°F. If it appears in real time that the LCRU cooldown will be excessive, a decision will be made to cover part of the LCRU radiator with its insulation blanket, prior to the return of the astronauts to the LM for their rest period.

(b) The cooling rate of the LRV battery will decrease due to the imposition of an additional heat source on its radiator, namely the solar energy reflected from the open cover onto the radiator. There is more flexibility in this deviation than in II(a) above, thus permitting a 20° deviation from the nominal heading away from the solar vector while only 10° deviation is permitted from the nominal towards the solar vector. This is illustrated in Figure 2.

IV. Conclusion

It can be concluded that a deviation of a few degrees from the nominal parking attitude is tolerable from the thermal standpoint. The exact magnitude of the acceptable deviation is contingent on the temperature attained by the LCRU and/or the LRV batteries at the conclusion of each EVA, the dust conditions and the sun elevation angle. It is understood that a decision will be made in real time as to whether to instruct the astronauts to readjust the parking heading after their first try.

A. S. Haron

2013-ASH-jab

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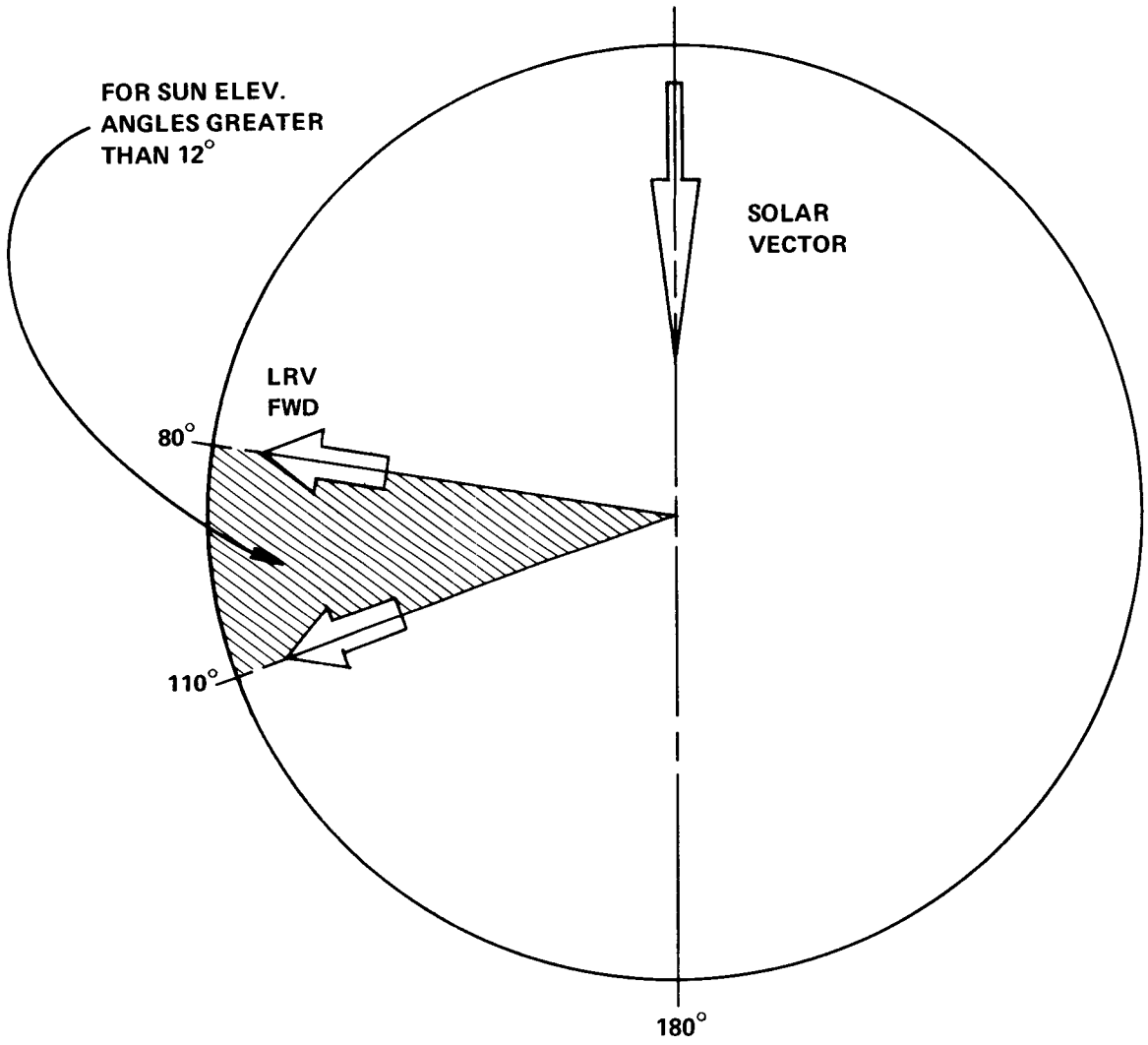
Attachments

REFERENCES

1. Donham, C. F. and J. A. Utz, "LCRU Cooldown Parametric Thermal Analysis," Boeing Document #SNR 12.1-10-2920-291, January 21, 1972.



SHADED AREA INDICATES THE PARKING ATTITUDES ACCEPTABLE TO THE LRV AND TO THE PAYLOAD

FIGURE 2 - LRV PARKING ORIENTATION CONSTRAINTS

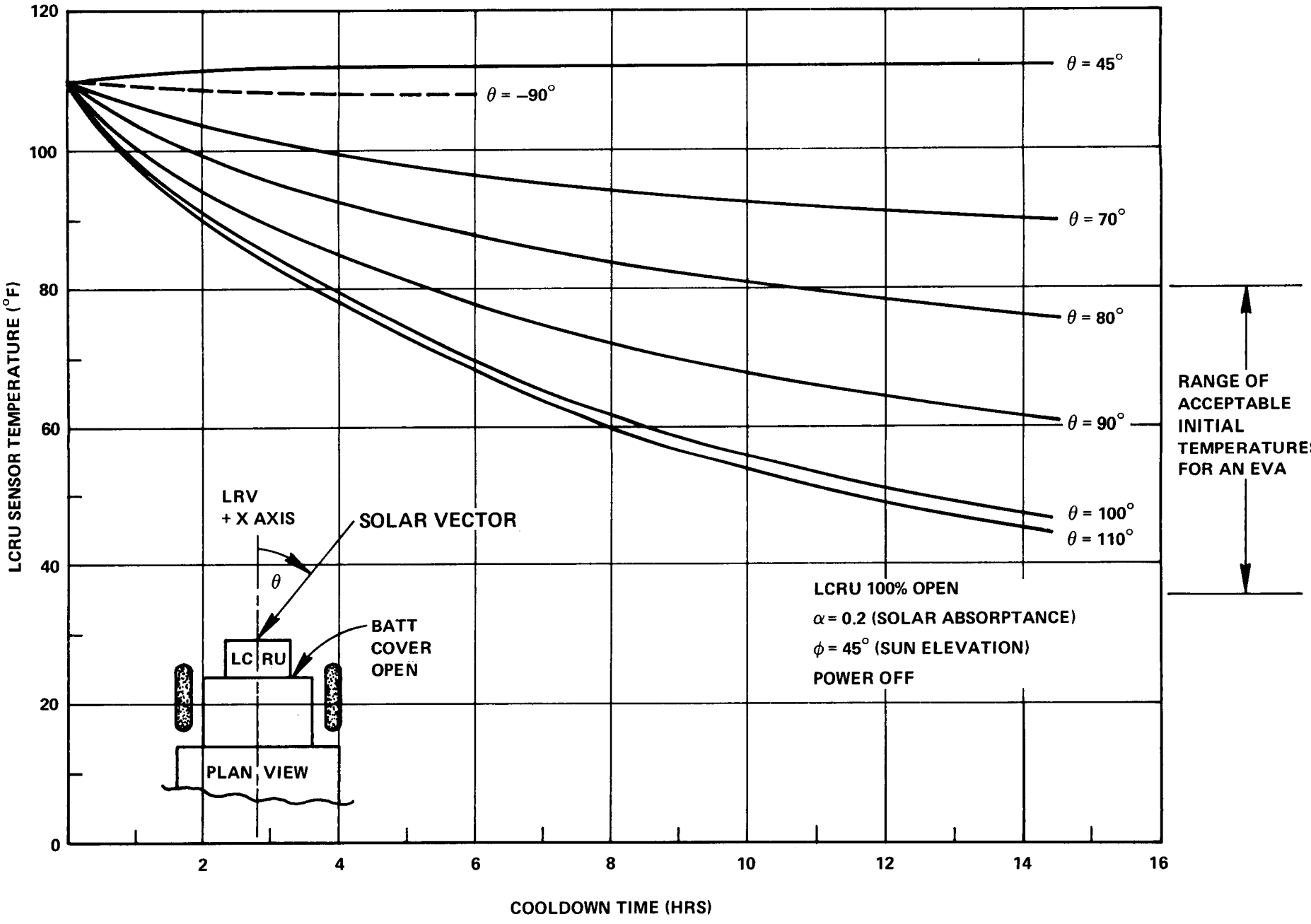


FIGURE 1 - LCRU COOLDOWN FOR VARIOUS LRV ORIENTATIONS

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